PATENT APPLICATION

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re application of

Toshiharu KAJITA

Docket No: Q67077

Appln. No.: 09/985,847

Group Art Unit: 3683

Confirmation No.: 4461

Examiner: Matthew C. Graham

Filed: November 06, 2001

For: BALL SCREW

DECLARATION UNDER 37 C.F.R. § 1.132

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Sir:

I, Toshiharu Kajita, hereby declare and state:

THAT I am a citizen of Japan;

THAT I have received the degree of Engineering Master in 1982 from Nagaoka University of Technology;

THAT I have been employed by NSK LTD. since 1982, where I hold a position as manager, with responsibility for Development of Machinery & Parts;

THAT I am the inventor of the invention described and claimed in the above-identified application.

THAT I have reviewed the specification and claims of the present application, and am well acquainted with the specification and claims of the present application.

THAT I have further reviewed the Official Action of October 1, 2003 issued in the present application and have reviewed the Examiner's position and all prior art relied upon by the Examiner and am well acquainted with all of that material.

THAT in order to demonstrate the unexpected superiority of the present invention, the following experimentation was conducted by me or under my direct supervision.

EXPERIMENTATION

As the ball screw, such a screw was prepared having

diameter of the screw shaft: 20 mm,

lead: 10 mm,

diameter of the ball: 3.969 mm and

circuit number: 1 raw of 2.5 wind.

This ball screw (Sample No. 1-1) had an average surface roughness (Ra) in both nut and shaft grooves of 0.12 μm, following along a helical direction of the helical raceway. The sample was attached to a noise measuring apparatus Sound Level Meter Unit UN-04A with Microphone which were produced by RION CO., LTD, the screw shaft was rotated at rotation number: 4000 rpm, and noise generated in the ball screw was investigated at a position of 400 mm apart from an axial center of the screw shaft.

As Sample No. 1-2, a ball screw of the same structure as that of Sample No. 1-1—excepting the following points—was prepared for performing the same test. Since this ball screw was not carried out with the super finishing after polishing when forming the ball rolling groove of the nut, the surface roughness of the ball rolling groove of the nut was 0.18 μm in the average roughness (Ra) following the helical direction of the ball rolling grooves.

As Sample No. 1-3 (Comparative Example), the ball screw of the same structure as that of Sample No. 1-1—excepting the following points—was prepared for performing the same test. In this ball screw, separators were not disposed between all balls, so that the balls were closely arranged.

As Sample No. 1-4 (Comparative Example), the ball screw of the same structure as that of Sample No. 1-1—excepting the following points—was prepared for performing the same test. Since this ball screw was not carried out with the super finishing after polishing when forming the ball rolling groove of the nut, the surface roughness of the ball rolling groove of the nut was 0.18 μm in the average roughness (Ra). Further, separators were not disposed between all balls, so that the balls were closely arranged.

As Sample No. 1-5 (Comparative Example), the ball screw of the same structure as that of Sample No. 1-1—excepting the following points—was prepared for performing the same test. Since this ball screw was not carried out with the super finishing after polishing when forming the screw shaft and the ball rolling grooves of the nut, the surface roughness of the ball rolling groove of the screw shaft was 0.19 μm in the average roughness (Ra) following the helical direction of the ball rolling groove. Further, the surface roughness of the ball rolling groove of the nut was 0.18 μm in the average roughness (Ra) following the helical direction of the ball rolling groove.

As Sample No. 1-6 (Comparative Example), the ball screw of the same structure as that of Sample No. 1-5—excepting the following points—was prepared for performing the same test. In this ball screw, separators were not disposed between all balls, so that the balls were closely arranged.

Noise values of respective samples were measured, and noise-reduction values were calculated, wherein the noise-reduction values were calculated on the basis of the difference in measured noise values of the samples in comparison with the noise value for Sample 1-6, wherein Sample 1-6 was given the standard value of zero (0). The results are summarized in Table 1.

Table 1

No.	Ra(. m)of Groove		Separator	Measured noise value (dB)	Noise reduction (dB)
	Screw shaft	Nut			
1-1	0.12	0.12	Present	67.0	-9.0
1-2	0.12	0.18	Present	68.0	-8.0
1-3	0.12	0.12	Absent	72.0	-4.0
1-4	0.12	0.18	Absent	73.0	-3.0

1-5	0.19	0.18	Present	74.5	-1.5
1-6	0.19	0.18	Absent	76.0	Standard

As is seen from the results, in Samples Nos. 1-1 and 1-2, wherein separators were disposed between all the balls, and wherein the surface roughness of the screw shaft and the ball rolling grooves (in No. 1-2, only the ball rolling groove of the screw shaft) were made 0.12 μm or less in the average roughness (Ra) following the helical direction of the ball rolling groove, larger noise-reduction values (that is, an unexpected excellent noise reducing effect) were obtained than was expected by adding the noise-reduction value due to any one of the two operations (specific surface roughness, and use of a separator) separately.

The noise-reduction value of No. 1-1 was expected to be "-5.5 dB", being the addition of the noise-reduction values of No. 1-3 (use of specific surface roughness) and No. 1-5 (use of a separator). But unexpectedly, the noise-reduction value of Sample No. 1-1 was "-9.0dB", which corresponds to 1.64 times the expected value. Similarly, the noise-reduction value of No. 1-2 was expected to be "-4.5 dB", being the addition value of the noise reduced values of No. 1-4 (use of a specific surface roughness) and No. 1-5 (use of a separator), but unexpectedly was "-8.0dB" corresponding to 1.78 times the expected value.

Therefore, I submit that the specifically claimed surface roughness value of a helical ball-rolling groove, in combination with use of a separator, as in the presently claimed invention is an important feature of the present invention, and that the presently claimed invention exhibits unexpectedly superior results due to these characteristics.

I declare further that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

Date: January 30, 2004

Toshiharu Kajita

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